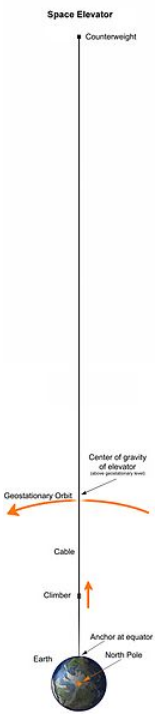
7.3: Other Propulsion Systems

7.3.1 Space Elevator

Rockets remain the only way we can get people and payloads into space. In theory, we could use a space elevator. Long a staple of science fiction, a space elevator would involve a long tether. We could anchor one end of the tether to a point on the surface of the Earth while connecting the other end to a space station in **geostationary equatorial orbit** (GEO), an orbit in which the satellite remains over a fixed point above the equator. Theoretically, an elevator running up the tether could lift payloads into the space at a lower cost than rockets. However, there is one problem: We do not have any material strong enough to run the 35,786 kilometers (22,236 miles) between the surface and GEO. Carbon nanotubes are one possibility, but so far, we can only make them a few centimeters in length. So, until we can solve this and a few other engineering issues, a space elevator will have to remain science fiction.



A space elevator may one provide a cheap means of transporting people and cargo into orbit.

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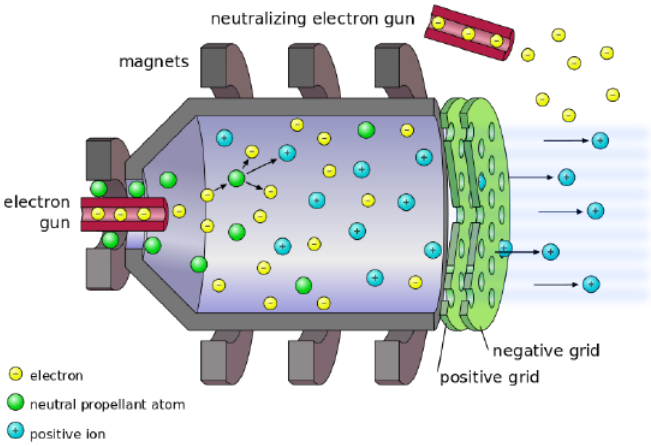
7.3.2 Ion Engines

Another limitation for rockets is that they require a large amount of fuel and fuel is mass. There is a point of diminishing returns where the mass of additional fuel outweighs the added thrust it can produce. To provide alternatives to using rockets to send probes out into the Solar System, researchers have explored some alternatives to rockets, such as ion drives, solar sails, laser sails, and magnetic sails.



Electric or ion thrusters can provide continuous thrust with minimal mass.

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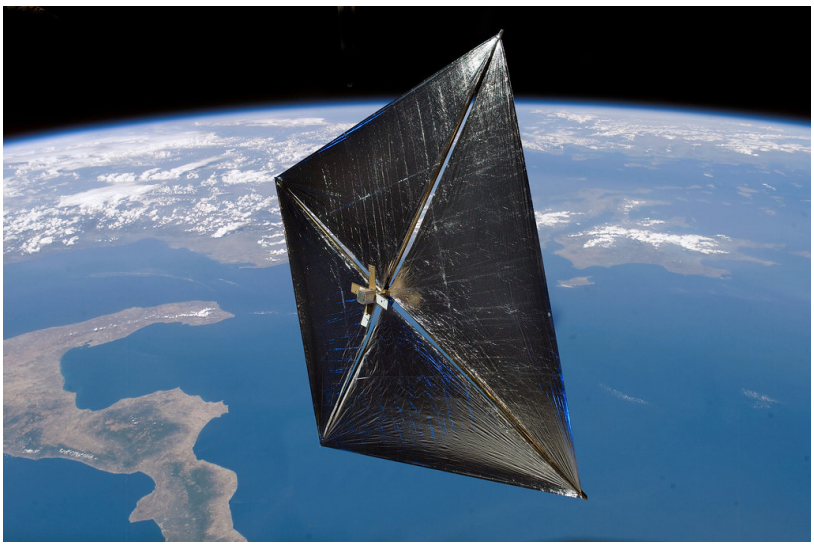
An ion drive, sometimes called a plasma drive, is one kind of an electric propulsion system. In an electric drive, source of electricity, such as solar or nuclear, heats up a gas such as hydrogen. The hydrogen would expand as it heats up and the drive could use that expansion to generate thrust. A plasma drive takes things step further and uses electricity to strip a gas of its electrons, converting it into a plasma. Then, it expels the plasma to generate thrust. While this would only generate a small thrust, a plasma drive could run continuously with much less mass than a rocket would require. Over time, the thrust would accelerate, pushing the craft to very high velocities. NASA first tested an ion drive in its Deep Space I and has used them on a few other missions.

7.3.3 Solar Sails

Solar sails use a thin sheet of material with a very high surface area to mass ratio. Light from the Sun exerts a tiny amount of pressure which produces thrust. With a large area, a solar sail could capture a lot light pressure and use to gradually reach high velocities. The Planetary Society just recently successfully deployed Light Sail 2 using cube sats. Japan's space agency, JAXA, has also tested a solar sail. This proof-of-concept could be scaled up to reach the outer solar system.

Like a solar sail, a laser sail uses light pressure. Instead of capturing light from the Sun, a laser sail would use light from a laser. A station in Earth orbit or on the Moon could fire the laser continuously to provide thrust and accelerate the probe to high velocities. Some proposals for laser sails estimate they could reach Mars in three days, as opposed to six months using conventional rockets. Variations of a laser sail include using a laser to ablate (convert from solid to gas) the surface of a craft to generate thrust or use a maser (microwave laser) to push a metal mesh. Another variation proposes firing a steady stream of pellets at a craft to push it.



Solar sails have been tested as a means of propulsion for traveling in the Solar System.

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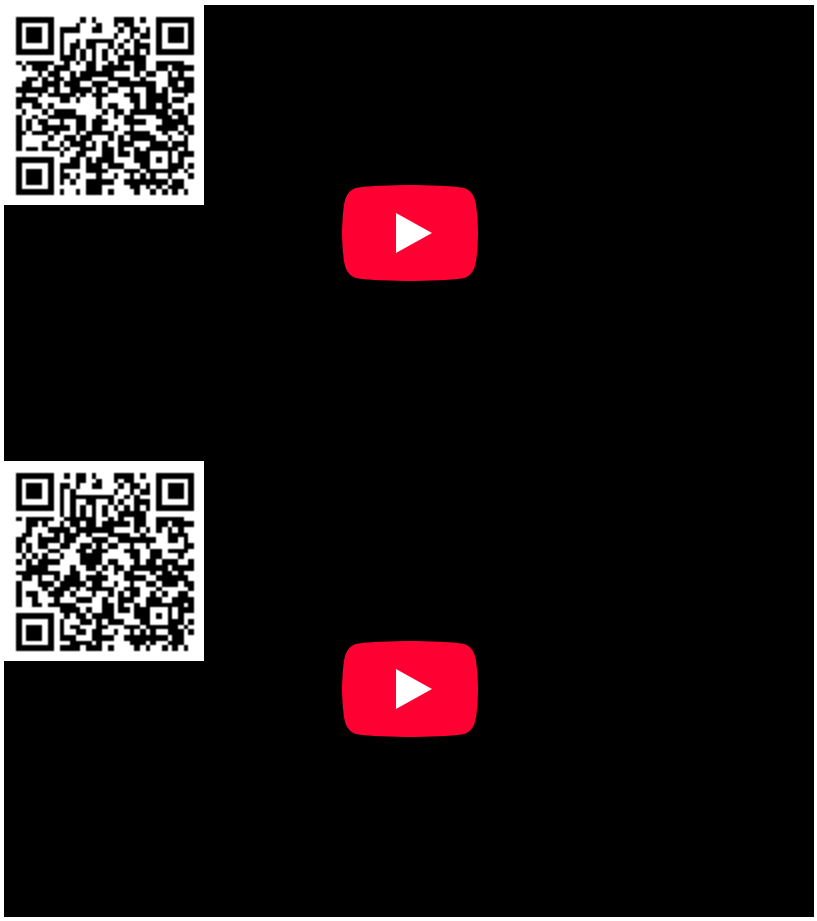

7.3.4 Magnetic/Electric Sails

Finally, a magnetic sail would create a “sail” out of a magnetic field around a metal mesh. Instead of sunlight, this magnetic field would gain thrust from the solar wind.